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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
A21B 1/24, F24C 15/32, F22B 27/16

A1

(11) International Publication Number: **WO 97/33479**

(43) International Publication Date: 18 September 1997 (18.09.97)

(21) International Application Number: PCT/DK97/00110

(22) International Filing Date: 12 March 1997 (12.03.97)

(30) Priority Data:
0291/96 12 March 1996 (12.03.96) DK

(71) Applicant *(for all designated States except US)*: AKTIEBOLAGET ELECTROLUX [SE/SE]; Luxbacken 1, Lilla Essingen, S-105 45 Stockholm (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: ELMAR, Junker [DE/DK]; Hannerupsvænget 8, DK-7000 Fredericia (DK). ESKILDSEN, Christian [DK/DK]; Dammen 14, DK-5591 Gelsted (DK).

(74) Agent: BROCK-NANNESTAD, George; Electrolux EPDH Tech-Centre, Sjaellandsgade 2, DK-7000 Fredericia (DK).

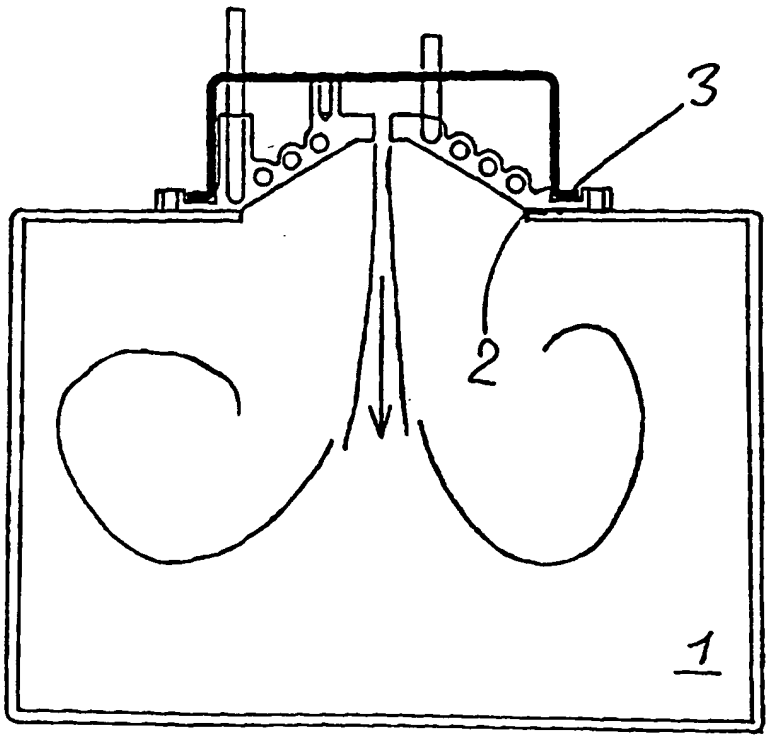
(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A GENERATOR FOR STEAM

(57) Abstract

A generator for essentially dry steam evaporates water as it runs down an inclined heated surface along guide means. The steam is collected near the top of the inclined surface and exits into a cavity via an orifice. This prevents splashes from reaching the cavity. In a preferred embodiment the inclined surface is conical and the guide means is a continuous spiral shaped wall on the conical surface.



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A generator for steam.

The invention relates to a generator for essentially dry steam using the evaporation of water falling on a heated surface.

Steam is used to transport heat by the very efficient evaporation/condensation process from the heat source to the heat consumer, e.g. food being heated in an oven cavity. Drops carried with the steam injected will only contribute the heat corresponding to the temperature difference, weight, and heat capacity of water whereas condensed dry steam will contribute the heat of condensation e.g. 500 times as efficient, dependent of the conditions of flow. It is well-known to generate steam by boiling water in a closed container, and to carry it to its place of use by means of a conduit. It is also well-known to generate steam by letting drops fall on a surface which is kept at a temperature appreciably above the boiling temperature of water. Usually, splashes or droplets generated when the drop impinges on the surface are caught by splash guards in order that the generated steam does not carry water drops.

Due to the creation of a very thin and insulating layer of steam at the interface between the heated surface and the water drop, the heat transfer to the drop is mostly not very efficient which is proven by the fact that a drop may take up to 10 seconds to evaporate. It has been recognized that disrupting the layer of steam may increase the evaporation efficiency remarkably. The invention is hence materialized in that the water falls on an inclined surface having guide means causing it to take a path along the inclined surface with a lenght sufficient to permit complete evaporation before the diminishing amount reaches the confines of the inclined surface. It is considered that the combination of running and sliding along the path

causes fresh water-to-heater contact through the complete and very shortened evaporation cycle. This is a considerable improvement over known steam generators. This advantage is obtained for a large variation in the amount supplied, i.e. both for dropwise administering of the water and for the supply of a continuous stream.

An advantageous embodiment of the invention is particular in that the inclined surface is a conical surface, and the path is defined by a downwardly spiralling track on said conical surface. In this manner, the steam outlet from the generator may be placed at the apex of the cone which is also the top, and thereby the splash guard is obtained automatically.

In a further advantageous embodiment there is disposed in the track a wick-like structure of wire mesh or porous material, such as sintered metal. This further disrupts the creation of an insulating steam layer, and the water is pulled along by capillary forces to reach areas which have not yet been cooled by evaporation.

A further advantageous embodiment is particular in that the downwardly spiralling track is confined by ridges containing a heating element. In this manner it is obtained that the material constituting the cone is used as efficiently as possible, because there is a nearly constant thickness of cone material surrounding the heating element. This embodiment is preferably manufactured by casting an alloy which is corrosion resistant and a good heat conductor around the heating element.

Another advantageous embodiment is particular in that a spiralling heating element is hard soldered or welded onto a conical metal cone, so that the track is defined between the cone and the heating element. In this manner, a still simpler manner of manufacture than the casting process may be used, e.g. an industrial welding robot.

The invention will be further described with

reference to the drawing, in which

Fig. 1 shows a section through an oven cavity with a steam generator according to one embodiment of the invention, and

Fig. 2 shows the steam generator in a vertical section.

In Fig. 1 is shown an oven cavity 1 which has a circular hole 2 in the top plate. The hole is completely covered by a steam generating unit 3.

In Fig. 2 this is shown in greater detail. The steam generating unit 3 consists of a base 4 and a bowl shaped cover 5 which in the present embodiment is secured to the base by a sealing compound. These parts define a hollow space S between them. The base 4 is shaped like a cone with a smooth inside surface 6 and a surface with a spiral-shaped ridge 7 on the outside. The ridge spirals down the conical surface and defines a channel or passage 8 between consecutive windings of the ridge which equally passes down the cone with continuously increasing radius. Inside the ridge 7 is disposed a spiral-shaped heating element 9 of the type consisting of an outer tube 10 of heat-resistant steel, inside which is compressed a ceramic insulating material 11, and a central resistance wire 12, which may itself be coiled. The shape of the spiral-shaped heating element corresponds closely to the ridge, and in practice the base 4 is cast in a corrosion resistant and heat conducting alloy, such as silumin with the heating element 10 being fitted in the mould. The ends 13, 14 of the heating element pass through the cover 5 in order to be connected to an electrical power supply.

The base 4 is provided with a bore 15 at the apex of the cone so that there is communication between the hollow S and the inside of the oven cavity 1. A pipe 16 is connected through the cover 5 and ends just above the top part of the channel 8. In use a pump feeds water via the pipe 16 to the top of the channel, and it starts to

flow down the slope of the channel around the conical surface. When sufficient electric power is supplied to the heating element 9, the whole base is hot, and the amount of water from the pipe 16 begins to evaporate, i.e. turn into steam, when it impinges on the top of the channel 8, and it continues to evaporate as it passes down the channel. Some sizzling and splashing will go on, but the steam will obtain a partial pressure which is greater than the atmospheric pressure and will pass through the bore 15. As the bore 15 is near the top of the cover and certainly above the mouth of the pipe 16, no splashes will reach the orifice, and hence the steam which escapes is essentially dry. The relative placement of the parts will ensure that even at a high production rate of steam which means a high velocity through the bore 15, no or virtually no splashes or airborne droplets will be carried along the stream of steam.

The production rate may be controlled in various ways. The power may be supplied so that the base 4 obtains a temperature which ensures that an amount from the pipe 16 has just completed evaporation as the last remains of it reaches the bottom of the channel, whereupon a new amount should be supplied for continuous production of steam. The base temperature is dependent on the amount of water and the evaporation. This temperature may be mesured by a sensor positioned in a bore 17 in the base. The supply rate may be increased along with a suitable increase in power so that the whole amount is evaporated during the average travel time. Even if the supply of water should be too high with respect to the power, the excess water that will accumulate at the bottom of the cone inside the cover 5 will eventually boil off. It should be noted that what is produced through the present apparatus is essentially dry steam at atmospheric pressure.

The advantages of this embodiment of the steam generator according to the invention will be obtained in

every case where the steam is withdrawn from the top of the cone, even though it may be fed via a conduit to its place of use. Other uses than for cooking in an oven cavity may be imagined, such as capuccino making or cleaning.

PATENT CLAIMS

1. A generator for essentially dry steam using the evaporation of water falling on a heated surface, characterized in that water falls on an inclined surface having guide means causing it to take a path along the inclined surface with a lenght sufficient to permit complete evaporation before the diminishing amount reaches the confines of the inclined surface.

2. A generator according to claim 1, characterized in that the inclined surface is a conical surface, and the path is defined by a downwardly spiralling track on said conical surface.

3. A generator according to claim 2, characterized in that the downwardly spiralling track is confined by ridges containing a heating element.

4. A generator according to claim 2, characterized in that a spiralling heating element is hard soldered or welded onto a conical metal cone, so that the track is defined between the cone and the heating element.

5. A generator according to any of the above claims, characterized in that there is disposed in the track a wick-like structure of wire mesh or porous material, such as sintered metal.

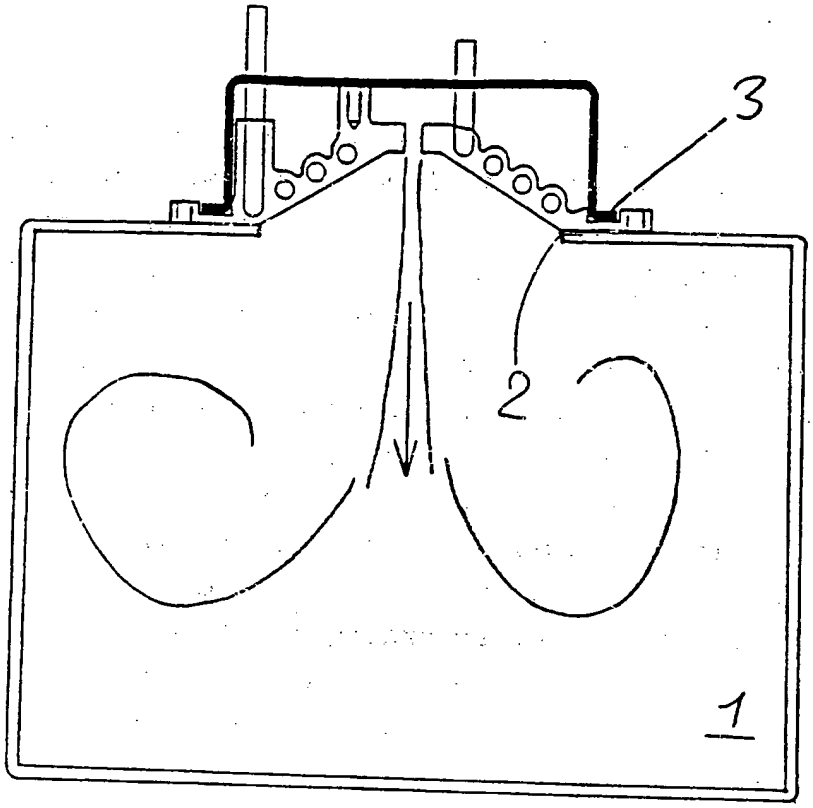

Fig. 1.

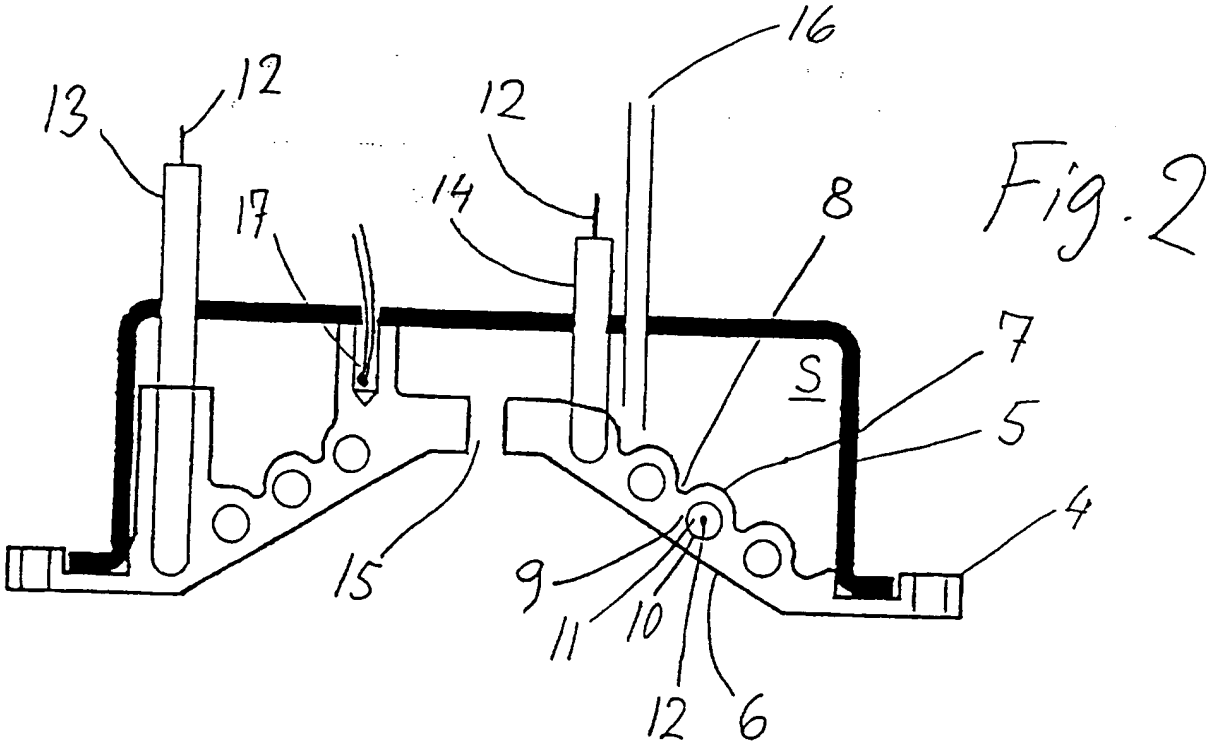

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 97/00110

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A21B 1/24, F24C 15/32, F22B 27/16
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A21B, F24C, A47J, F22B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2163845 A (MONO EQUIPMENT LIMITED), 5 March 1986 (05.03.86), figure 2, abstract --	1
X	EP 0640310 A1 (ANGELO PO GRANDI CUCINE S.P.A), 1 March 1995 (01.03.95), figures 1,12, abstract --	1
A	EP 0244538 A2 (LINCOLNFOODSERVICE PRODUCT, INC.), 11 November 1987 (11.11.87), figures 5,6 --	1-5
A	EP 0523489 A1 (ZANUSSI GRANDI IMPIANTI S.P.A.), 20 January 1993 (20.01.93), abstract --	1-5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 2836118 B1 (DEBAG, DEUTSCHE BACKOFENBAU GMBH), 8 November 1979 (08.11.79), figure 2, details 62, 66	1-5

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Information on patent family members

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